

Nature and Properties of Waves

PS-7 The student will demonstrate an understanding of the nature and properties of mechanical and electromagnetic waves.

PS-7.3 Summarize characteristics of waves (including displacement, frequency, period, amplitude, wavelength, and velocity as well as the relationships among these characteristics).

Taxonomy Level: 2.4-B Understand Conceptual Knowledge

Key Concepts:

Displacement of particles

Frequency: Hertz

Period

Amplitude

Wavelength

Velocity - meaning speed

Previous/Future knowledge: In the 8th grade students “summarize factors that influence the basic properties of waves (including frequency, amplitude, wavelength, and speed)” (8-6.1).

In Physical Science the students expand on this idea and summarize the relationships among these characteristics. Students will understand the relationship of the movement of the particles in the medium and the wave characteristics. In Physical Science the concept of displacement is introduced both with respect to the wave energy and with respect to the movement of the particles in the medium. -

It is essential for students to

- Understand characteristics of waves can be explained in terms of how the particles in the medium behave.
 - **Amplitude**
 - The amplitude is the greatest displacement of the particles in a wave from their equilibrium (rest) position.
 - In a transverse wave amplitude is measured from the equilibrium or rest position of the medium to a crest or trough.
 - **Displacement**
 - Displacement with respect to waves will refer to the displacement of the particles in the medium.
 - This quantity has magnitude and direction.
 - It is the distance of a vibrating particle from the midpoint of its vibration. (Displacement is used in discussing amplitude and interference of mechanical waves.)
 - **Frequency**
 - The frequency of the wave is the number of complete cycles (or vibrations) the particles go through per second or the number of waves that pass a point per second.
 - The unit for frequency is *Hertz*, which is one vibration per second or one cycle per second or one wave per second.
 - The frequency and the wavelength are inversely related. When the frequency gets higher the wavelength gets shorter.

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- ***Period***
 - The period of a wave is the time for one cycle (or vibration) or the time for one complete wave to pass a point.
 - The period is usually measured in seconds.
 - The period and the frequency are inversely related. An increase in frequency would result in a decrease in period.
- ***Wavelength***
 - Wavelength of a wave is distance between a point in a wave and the next similar (in phase) point.
 - In a transverse wave the wavelength can be measured from a crest to the next crest or from a trough to the next trough.
 - In a longitudinal wave the wavelength can be measured from point in the compression to a similar point in the next compression or from a rarefaction to a similar point in the next rarefaction.

Teacher Note: Since most longitudinal waves (such as sound waves) are not visible, the wavelength is often measured by indirect means.

- ***Velocity/Speed***
 - The velocity/speed of the wave is a function of the medium and the type of wave and will not change unless the characteristics of the medium or type of wave changes.
 - Changes in frequency or wavelength do not affect the velocity/speed (of mechanical waves). When one of these increases the other decreases and the product of the two is a constant, which is the velocity/speed.
 - When the medium changes, the speed of waves changes. Examples may include: Sound travels faster in steel than in air. Sound travels faster in warm air than cooler air. Light travels faster in air than in glass. Transverse waves travel slower in a heavy rope than in a light rope.

Teacher note: For purposes of this course wave velocity/speed will be treated as a scalar quantity. No direction needs to be indicated.

It is not essential for students to

- Know the speed of waves in certain media;
- Explain why waves travel slower in one specific medium than another.

Assessment Guidelines:

The objective of this indicator is to summarize the characteristics of waves, therefore, the primary focus of assessment should be to give major points about each characteristic of a wave and the relationships among these characteristics.

In addition to summarize, assessments may require that students

- Compare the characteristics of different types of waves;
- Exemplify and illustrate characteristics of different types of waves;
- Identify wave characteristics from a description or diagram;
- Interpret diagrams to determine wave characteristics.